# EXPERIMENTS ON THE COLONY FOUNDATION OF EUROPEAN ANTS[1]

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Since experiments on colony foundation in general have been needed for a long time, and since I have been able to work with only a few species and individuals up until now I am quite aware in presenting the following observations of the impossibility, at this time, of drawing from them conclusions that are relatively broad in their significance. I offer these observations to the public nevertheless, since as Eidmann[2] has pointed out, "Each success [of such an experiment] is to be marked down as a lucky incident," upon whose repetition we must not count with certainty. Above all, I hope to interest younger American myrmecologists in similar experiments, especially with the American races of the European species treated in this paper, since these races may show some degree of deviation in their behavior and may therefore deter us from making hasty generalizations.

1. *Messor barbarus structor* (Latr.)

This species is common in this vicinity. For some years I have observed as early as April, but never much later, numbers of the young wingless queens following the nuptial flight. This seems strange inasmuch as the mating of the other Myrmicinæ

[1] TRANSLATOR'S FOOTNOTE: This paper was translated from the manuscript of Dr. Molitor, which was entitled: "Versuche betreffend die Koloniegründing Europäischer Ameisen." Inasmuch as there is a critical paper shortage in many parts of Europe, few workers can now publish the results of their work. I was happy therefore to help Dr. Molitor in the matter of translating the present paper.

I wish here to express my appreciation to Miss Doris Sharpe of the Department of English for her kindness in eliminating some of my errors of English from the preliminary manuscript. Many thanks are also due my wife who kindly consented to type the final manuscript.—Prof. M. W. Wing, North Carolina State College of Agriculture and Engineering of the University of North Carolina, Raleigh, North Carolina.

[2] "Weitere Beobachtungen über die Koloniegründung einheimischer Ameisen", *Zeitschr. vergleich. Physiologie,* 7. Band, 1. Heft, 1928.

does not take place before the beginning of the astronomic summer (at the earliest, in late June for *Tetramorium;* at the latest, August to the end of October for *Solenopsis*). And furthermore the nuptial flight of *Messor structor,* a so-called "xerothermic species" of decidedly more southern distribution, would be expected in a warmer season. The mating takes place in November in the Mediterranean region, at least in the Balearic Islands, according to information received from Prof. Eidmann. In the vicinity of Vienna the sexual forms of our species are to be found from the end of August in the nests, where they overwinter. The riddle then is solved very simply by the assumption that the seemingly very early nuptial flight is in actuality a delayed one caused by the comparatively colder autumn weather of our region where, after the emergence of the males and the queens in a given year, nothing more can take place.

Concerning the colony foundation of *M. structor,* there exist so far as I know only the experiments of E. Meyer[3], who on this subject states among other things: "The nutrition of the young ant family and the mother ant herself, while they are still shut off from the outer world occurs . . . above all at the cost of the eggs laid by the queen, and also to a certain degree other immature stages (larvæ)." Prof. Eidmann is inclined, and I think correctly, to associate this kind of ant nutrition with the independent[4] method of colony foundation. If it occurs in *M. structor* (a grain ant), which lives principally on vegetable food, then it certainly must occur in carnivorous ants.

My own experimental plan varied from that of Meyer, with which I was not then acquainted, in that I placed together in a roomy glass container furnished with some moist earth, two young wingless queens which had just been collected on the surface of the ground. The queens were fed with rice, dough, and seeds. The result was that they soon began to lay eggs, from which larvæ hatched. By the beginning of the summer these larvæ had developed into large and small workers. *Messor* work-

[3] "Die Ernährung der Mutterameise und ihrer Brut während der solitären Koloniegründung", *Biol. Zentralbl.* Band 47, 1927. Cited from the abovementioned work of Eidmann.

[4] That is, colony foundation by a lone queen, without the help of workers of her own or of another species.

ers are typically dimorphic. The two queens lived at complete peace with each other not only before the appearance of the workers, but also for a long time thereafter. During this time I never observed fights between them, but one day I found the body of one of the queens without the head. It lay nearby, appearing to have been bitten off. Unfortunately, it was impossible to determine whether the other queen or perhaps some of the workers were the culprits.

In one of the cases which Meyer reported a *M. structor* queen lived 396 days without food, but did not succeed in founding a colony. She had replenished the dwindling reserve materials of her body by eating her own brood. It should not, however, be assumed that the success of colony founding is dependent upon food. On the contrary, according to the accounts of Prof. Eidmann, which, of course, deal with other species also characterized by independent colony foundation, it appears that the feeding of the queen before the emergence of the first workers tends to endanger the outcome.

2. *Tetramorium cæspitum* (L.)

About four or five young deälated queens were captured at the end of June last year. They were all put into a glass container like the one mentioned above. They received moist sand[5] for nest material, but they were not fed. After a relatively short time, still in the month of July, I found adhering to one another in this nest a sizable group of eggs, which the queens, who were completely friendly, were tending together. Unfortunately I lost this colony because of my lack of attention and my forgetfulness. I neglected it when it should have been watered. Whether the artificial Pleometrosis (in the sense of Wasmann) would have continued is difficult to say. Since I collected the queens all in close proximity to one another and at the same time, approximately within one or two hours, it is quite possible that they all came from the same nest. The possibility of their all having the same common nest odor may have accounted for their friendly association with one another. In

[5] Sand is especially suitable for this purpose, since it becomes moistened throughout, does not mold, and allows the ants to dig and build with ease.

nature I have never found more than one queen in a *Tetramorium* nest.[6]

3. *Formica fusca rufibarbis* Fabr.

In June of last year I found a young queen that was crawling over the surface of the ground after the nuptial flight. I put her in a broad glass medicine bottle, which was partially filled with moist sand and was closed with a metal screw cover.[7] On the first of July I saw the first eggs which she had laid; there were about half a dozen of them in all. About two weeks later there were four small larvæ, which had pupated by July 27. These cocoons were the smallest I have ever observed for *rufibarbis*. The workers emerged in August. I kept only occasional notes on this colony and not a really complete record, and therefore I cannot say with certainty that some eggs, or the larvæ that hatched from them, were not at times devoured by the queen. I believe, however, that it was no more true than with my comparable experiments of this year. At least I was unable to note any difference in this behavior.

Again on June 21 I found a *rufibarbis* queen and put her in a bottle of the type mentioned above. By digging in the sand she made a cavity in one corner of the bottle, which was square in cross-section. On July 4 I noticed about six to ten eggs stuck together in this brood chamber, which was open above. On July 8 the eggs were still stuck together, and apparently their number had neither increased nor decreased, but they were no longer in their corner. The queen had moved them, presumably because of the disturbance made when the cover was unscrewed. The eggs had hatched at the latest by July 14. By July 19 the small larvæ had grown visibly, and after a few days they were no longer in the brood chamber, but rather were

[6] In order to capture the queens, large flat stones are laid suitably on the soil nest in question. This is best done in the early spring during the late afternoon hours. Later on in the season toward summer, it is best done in the evening hours, particularly after long rains. The stones are turned over after a few days. Not only is the queen usually found, but also the greater part of the brood and, above all, the myrmecophiles (beetles, etc.). This method can also be used profitably with other species which build earth nests.

[7] This screw-type cover is advantageous if the cover is not closed so as to exclude all air, but is rather used to slow down a too rapid evaporation.

piled in a small heap on the surface of the sand near the opening. The queen remained by them constantly.

On July 24 all the larvæ had pupated. The pupæ rested in relatively very small cocoons; they were approximately the size of *Lasius* cocoons. By August 9 there were no changes; the queen seemed quite lively and vigorous. This was also the case on August 12. On August 15 the first worker emerged. The duration of the pupal period was about three weeks, as in the previous year. Up to the time of the emergence of the first workers, the queen was not fed. From that time up to August 29 there were no changes in this colony, which seemed to be in the best of health. Particularly worthy of note is the fact that the queen laid no more eggs in so far as I was able to observe, even though I often looked with a magnifying glass.

4. *Formica rufa rufa* L. and *Formica rufa pratensis* Retz.

The colony founding of this species, and of the species group in general, is known to be "dependent"; that is, the young fertilized queens require the help of workers of their own or of a closely related species. Usually *Formica fusca* subserves this function, and then there results at first a "temporarily mixed" colony (in the sense of Wasmann) of *rufa* and *fusca* or of *pratensis* and *fusca,* which later becomes a pure *rufa* or a pure *pratensis* colony following the dying off of the *fusca* workers. I am aware, of course, of the fairly common case in which a young *rufa* queen is accepted in a colony of her own species. This is about the way myrmecological literature represents the matter. Since I was trying to duplicate these relationships as faithfully as possible, following their nuptial flight, I placed the young deälated queens, which I had captured in various places, on the surface of the ground (May to June), in containers with *fusca* workers. In order to facilitate the acceptance of the queen, I first bathed her so as to free her as much as possible from the foreign *fusca* nest odor and of the species odor, or in the latter case at least to weaken it temporarily. Furthermore, I isolated her for a period of at least a day in a container with nest material from the *fusca* nest in question. Also I always used only a small number of *fusca* workers on the supposition that they would be less belligerent than a large group, and I

introduced them one at a time and gradually (at least for all the later experiments) into the queen cage. These *fusca* workers were without brood—only workers. In spite of all of these precautions, I never did get anything in the way of positive results. If the *rufa* and *pratensis* queens were not attacked, as occasionally occurred, then they were merely tolerated, without being adopted in any true sense of the word. I never observed feeding of the queen by the workers, and always after a few days I found the queen dead. I was unable to account for the persistent failure of these experiments.

5. *Formica sanguinea* Latr.

At first I was unable to get any better results in comparable experiments on this species until I decided to furnish the queens with pupæ, not workers, of a different species. I found two young deälated queens crawling on the surface of the ground on June 26 and put each one of them into a separate glass container of the type already described for *rufibarbis*. Each one of the queens received a small number of *pratensis* pupæ, which were thrown in to them irregularly. They immediately took the pupæ and carefully made a little pile out of them. On July 4 and 5 the first *pratensis* workers emerged. I noticed on July 19 in one of the culture bottles, that had obviously become too moist, a heavy growth of mold, which had killed all of the *pratensis* workers. However, the *sanguinea* queen was left safe and sound. She was changed to another culture bottle, which contained only *rufibarbis* pupæ, the first of which began to emerge on August 14. On July 25 the queen had laid a few eggs, which, however, had disappeared a few days thereafter. It is possible that they were eaten. Up until August 31 there were no changes which could be detected in either of these colonies; particularly there were no more eggs laid. On occasions I observed the feeding of the queen by the *pratensis* workers.

The normal slave ant of *F. sanguinea* in Europe is *F. fusca* and its race *rufibarbis*, occasionally and by way of exception (in this vicinity at least) *F. fusca gagates*. There are, however, naturally occurring mixed colonies of *sanguinea* and *rufa* and also of *sanguinea* and *pratensis*. Since *pratensis* is much more common in certain localities, *sanguinea* is more likely to locate

this race. My experiments were not intended to demonstrate this possibility, but rather to clarify the beginning stages of a *sanguinea* colony, particularly in comparison with those of a colony of *Polyergus rufescens*.

6. *Polyergus rufescens* (Latr.)

On July 24 I captured a young queen of this species after the nuptial flight, and on the following day I placed her in an observation nest. It contained likewise a small number of *pratensis* worker pupæ, to which she, however, quite unlike the *sanguinea* queens, gave no attention at all. A few days thereafter I found her dead. The usual slave ant of *Polyergus* is *F. fusca* and *rufibarbis*. However, according to Wasmann, naturally occurring mixed colonies of *Polyergus rufescens* and *Formica rufa pratensis*, which I had wanted to duplicate, are occasionally found. The fact that the *Polyergus* queen did not pay any attention to the *pratensis* pupæ may have had its basis in that it is not the normal slave species. In my experiments,[8] on

[8] I am borrowing material on this subject from my daily notebook: On July 27 I took from their nest a considerable number of *Polyergus* workers and some of their slave ants (*rufibarbis*). About ten steps away from this nest, I poured out onto the ground a small pile of *pratensis* worker pupæ and, since it was not easily avoidable, also a few *pratensis* workers themselves. Then I poured the *Polyergus* together with their few slave ants on them. Naturally at first there was a battle with *pratensis*, which, however, did not result in any deaths. After a few minutes single *Polyergus* workers seized a few pupæ in their mandibles and carried them around in the tumult, apparently without any plan or purpose, usually letting them drop again soon. Also the *rufibarbis* joined in, only more effectively, and soon I noticed two of them on the way toward their nest with pupæ. To be sure, in the grass their movements were rather meandering, but on the foot path, which they had to cross, they moved with "purpose" in a perfectly straight line. About a quarter hour after pouring out the ants, these two had reached the nest. After another quarter hour the *rufibarbis* had carried into the nest two pupæ, which I believed to be *Polyergus* although I could not ascertain definitely; and like the previous *rufibarbis* workers, they moved in a winding manner in the grass, but travelled in a straight line on the foot path to the nest. Thirty-five to forty minutes after the beginning of the experiment they had reached the nest with their burdens. At the place where the ants were poured out, a few *Polyergus* were still running about, some with and some without pupæ.

On August 7 I repeated the same experiment with *Polyergus* workers from the same nest. This time, however, I obtained fewer results. Only

the contrary, workers have carried off such pupæ. Probably more consistent with a true picture and with the former indifference, if not the psychic inability of *Polyergus* to do nest-work of all kinds (not merely brood care) is the assumption that the queen of this species is completely incapable of founding a colony in this way, but rather that such a fertilized queen requires the help of slave ants. Does she break vigorously into the nest and kill the queen, or is she taken into a queenless colony in a friendly way by the workers? With *F. sanguinea,* on the other hand, it appears to me that according to the foregoing experiments the queen normally appropriates by robbery and brings up a small number of pupæ of the slave ant, although the other two above-mentioned possibilities should not be excluded. Only further experiments by a number of observers in different regions can clarify these matters.[9]

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a few workers seized the *pratensis* pupæ and carried them about a little, described Turner curves with them, but did not carry them to the nest. Others seemed indisposed to bother with them, as if these pupæ were too big for them. They were, to be sure, particularly well-developed pupæ, so that it is, in fact, quite possible that the behavior of the ants, which differed from the previous time, may be explained by this circumstance. Then I placed directly on the spot for them a small pile of *rufibarbis* pupæ, which are considerably smaller than those described above. The ants immediately seized them and very rapidly carried them to the nest, with fewer and shorter curves. On August 8 I performed the same experiment once again, but with workers from another nest. These ants seemed to struggle a great deal with these large, heavy *pratensis* pupæ, but they obviously could not handle them any more than their colleagues of the day before could. None succeeded in taking one of these pupæ between their mandibles in the normal manner. Immediately thereafter, I placed some *F. fusca* pupæ before them; these lay there quite unnoticed, although here the pupal size could play no part. The *Polyergus* crawled over them again and again without making a single attempt to seize them. In both of the nests here mentioned *rufibarbis* was the slave ant. It almost seems as though in the last experiment the usual species or race odor of *rufibarbis,* which differs from that of *fusca,* had played the deciding role, although it still remains difficult to understand why a like factor should not have value *a fortiori* for *pratensis.* This is especially puzzling because in a region next to open country, such as prevails, *rufibarbis* is clearly favored, occuring as the slave ant of *P. rufescens. F. fusca* also occurs as the slave of *P. rufescens,* if only by way of exception, as for example, at the edges of woods, etc. Only further experiments can clarify this matter.

[9] It is possible that this behavior of ants is also regionally different.